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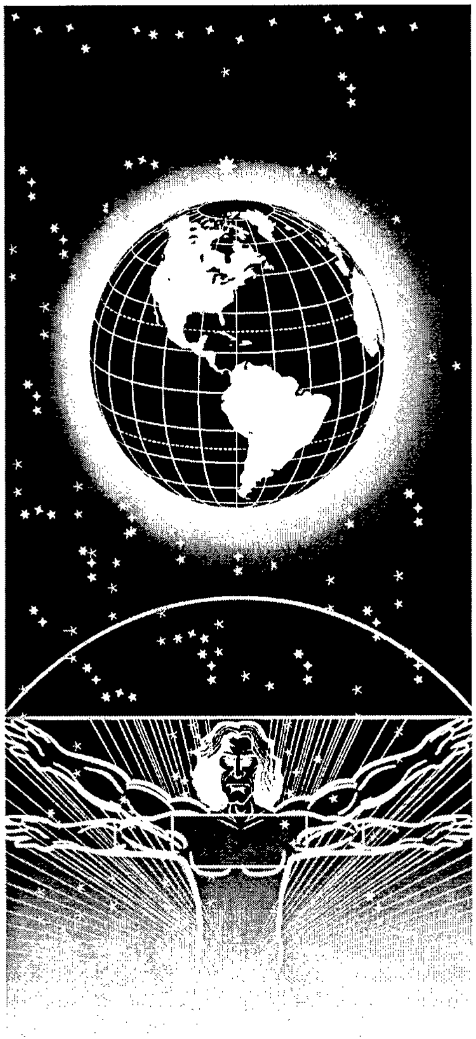

UNITED STATES AIR FORCE RESEARCH LABORATORY

SUITABILITY OF AVAILABLE REAR-PROJECTION SCREENS FOR DISPLAYING HIGH LINE-RATE LASER PROJECTOR IMAGES

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NOTICES

This report has been reviewed and is approved for publication.

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13. ABSTRACT *(Maximum 200 words)*

This report addresses the issue of the suitability of available rear-projection screens for displaying high line-rate laser projector images. Although there were some differences among the screens tested, there was no indication that the screen was the limiting factor in the spatial resolution of the display system.

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THE SUITABILITY OF AVAILABLE REAR-PROJECTION SCREENS FOR DISPLAYING HIGH LINE-RATE LASER PROJECTOR IMAGES

BACKGROUND

We have recently estimated the spatial resolution of several display systems consisting of various image generators, CRT projectors, and rear-projection screens. Although there were some differences among the screens tested, there was no indication that the screen was the limiting factor in the spatial resolution of the display system. However, to date, only relatively low line-rates have been tested (up to 1700 × 1350 pixels), and it is possible that the screen will limit the spatial resolution of higher line-rate display systems such as 5000 × 4000 pixel laser projectors. We have attempted to address this issue with the research described here. More definitive data will be obtained when a functioning laser projector becomes available for evaluation.

METHOD

Apparatus and Procedure

Test images were vertical, square-wave gratings projected using 35 mm slides and a Kodak carousel projector. The grating bar widths were either 0.25, 0.33, or 0.50 mm. Measurements were obtained from grating images either rear-projected onto a Proscreen 1.2 screen, or front-projected onto a piece of white paper located at the surface of the screen nearest the projector. It had previously been determined that the contrasts obtained using this paper were very similar to those obtained with a white, Lambertian reflectance standard.

The grating images were projected perpendicular to the screen from a distance of about one meter. Screen measurements were made perpendicular to the screen near its center. Relection standard measurements were made at a slight angle to the screen because the detector and slide projector were on the same side of the screen in this condition. Because of the approximately Lambertian nature of the reflectance standard, this angle did not significantly affect the measured luminance.

Spatial luminance distributions were measured using a Photo Research Model PR-719 Spot Spectrascan Fast Spatial Scanner. The scanner position was chosen to give about three cycles in the luminance distribution of the 0.5 mm grating. Maximum and minimum luminances (L_{max} *and* L_{min},, respectively) were measured over the grating cycle that was closest to the center of the luminance distribution. Michelson contrast was calculated from the luminance distributions as: $(L_{max}-L_{min}) / (L_{max}+L_{min})$.

RESULTS

Shown in Figure 1 are the luminance distributions obtained from both the rear- and front-projected grating images for the three grating bar widths (0.25, 0.33, and 0.50 mm) tested. The filled circles in each of the three graphs show the data obtained from the gratings

rear-projected onto the Proscreen 1.2. The open circles represent the data obtained from gratings front-projected onto the reflectance standard. The relative vertical position of the luminance distributions in each of the three graphs of Figure 1 indicates that the rear-projection screen reduced the overall luminance of the projected gratings by about 50% relative to the reflection standard.

The Michelson contrasts calculated for the various luminance distributions shown in Figure 1 are presented in Figure 2. The filled bars of Figure 2 show the measured contrasts of the rear-projected gratings, while the striped bars show the measured contrast for the front-projected gratings. For the two smaller grating bar widths, the contrasts measured through the rear-projection screen is nearly twice that measured from the reflectance standard. For the largest grating bar width, there was no significant difference between the measured contrasts of the rear-projected and front-projected gratings.

CONCLUSIONS

The 0.33 mm test grating corresponds to the line width that would be produced by a 5000 line laser-projector image distributed across the front screen of a Mobile Modular Display for Advanced Research and Training (M2DART) as it is typically configured. Based on measurements of test gratings of that size projected using 35 mm slides, we tentatively conclude that equivalent spatial detail produced by a laser projector will not be significantly degraded by the projection screens currently used in the M2DART. It is recommended, however, that this evaluation be repeated using a laser projector when one becomes available.

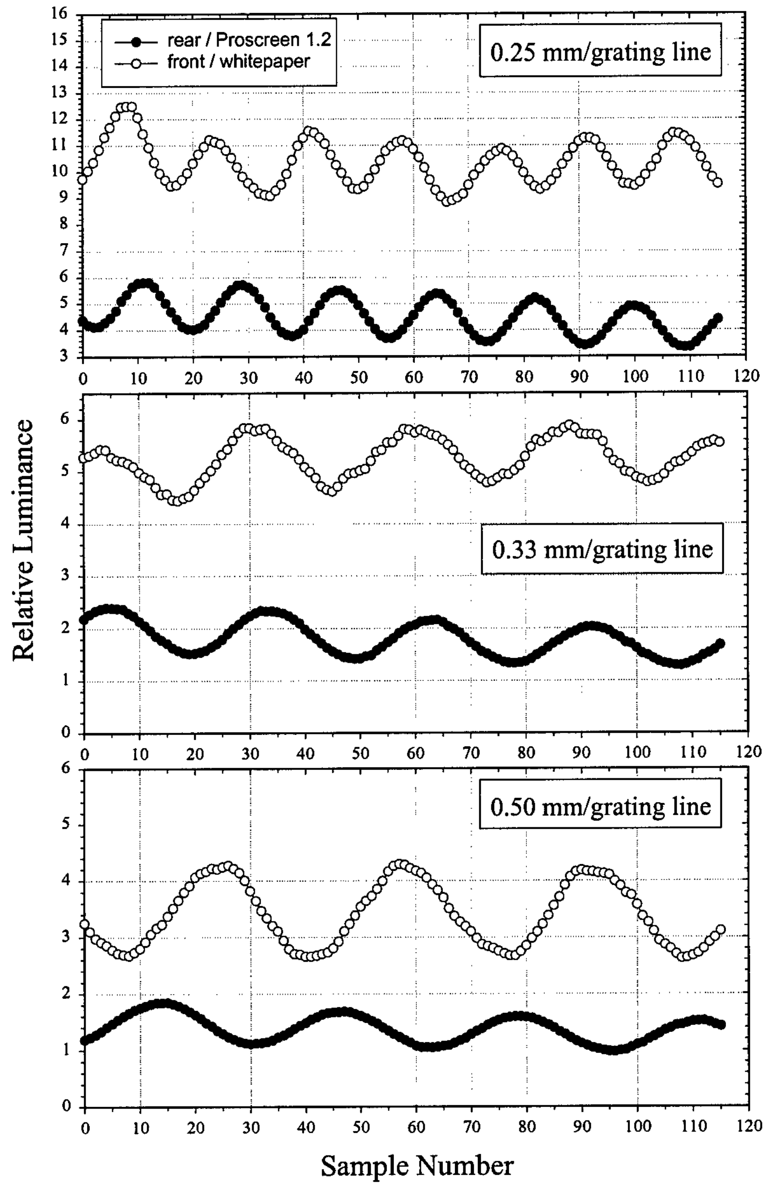

Figure 1. Spatial Luminance Distributions for the Test Conditions Shown.

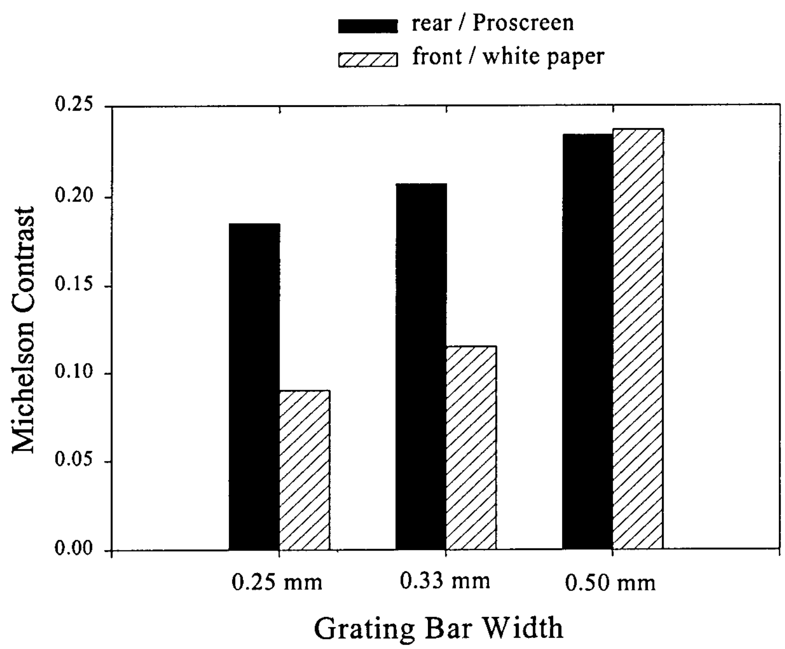

Figure 2. Michelson Contrast Calculated from the Spatial Luminance Distributions of Figure 1.